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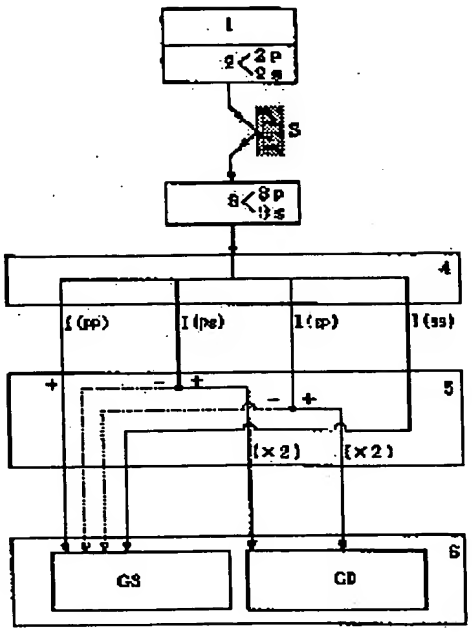
(54) METHOD AND DEVICE FOR OBSERVING SURFACE OF SKIN

(57)Abstract:
PURPOSE: To obtain an image adapted to an actual quality sensation of the skin so that the skin can be evaluated exactly, and also, to quantitatively determining a surface state of the skin at the time of photographing the surface state of the skin to the image, separating a skin surface state such as fine wrinkles and pores of the skin, etc., and a skin internal state such as stains and freckles, etc., and analysing and evaluating them.
CONSTITUTION: An S polarized light and a P polarized light are made incident on the surface of the skin, respectively, and an S polarized light component and a P polarized light component of a reflected light in the case the S polarized light is made incident, and an S polarized light component and a P polarized light component of a reflected light in the case the P polarized light is made incident are photodetected, respectively, and based on their photodetecting intensity I (pp), I (ps), I (sp), and I (ss), a surface reflected light component or an internal reflected light component in the case a natural light is made incident on the skin is derived independently, and a surface reflected light image GS or an internal reflected light image GD is obtained. Also, in the surface reflected light component, a component of a space frequency belonging to an equivalent visual sense band of a visual sense system of a person is extracted, and by forming a surface reflected light image, or integrating the power of the extracted component, the surface state is determined quantitatively.



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* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] S polarization component and P polarization component of the reflected light at the time of making a skin front face carry out incidence of S polarization and the P polarization, respectively, and carrying out incidence of the S polarization, And S polarization component and P polarization component of the reflected light at the time of carrying out incidence of the P polarization are received, respectively. The skin surface observation approach characterized by asking for the surface reflected light component or internal reflection component at the time of carrying out incidence of the natural light to the skin in independent based on those light-receiving reinforcement, and obtaining a surface reflected light image or an internal reflection image.
[Claim 2] The skin surface observation approach characterized by forming a surface reflected light image based on the component of the spatial frequency which belongs to the equivalence vision band of people's visual system among the surface reflected light components of the skin.
[Claim 3] The evaluation approach of the skin of integrating the power of the component of the spatial frequency which belongs to the equivalence vision band of people's visual system among the surface reflected light components of the skin, and evaluating the surface state of the skin based on this value.
[Claim 4] The exposure means to which it can become from the exposure light source and a polarizing filter, and a skin front face can be made to carry out incidence of S polarization and the P polarization, respectively, The polarizing filter which makes S polarization component or P polarization component of the reflected light by S polarization or P polarization which carried out incidence to the skin from this exposure means penetrate, The image pick-up equipment which receives S polarization component or P polarization component which penetrated this polarizing filter, the control computational unit to which a monitor is made to output a surface reflected light image or an internal reflection image based on the signal from image pick-up equipment, and skin surface observation equipment characterized by having a monitor.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the skin surface observation approach and skin surface observation equipment. Furthermore, in detail, this invention relates to the skin surface observation approach and skin surface observation equipment which obtain separately the reflected light image on the front face of the skin, and the reflected light image inside the skin using the polarization property of light, in order to carry out analysis evaluation of the irregular colors, such as a stain inside the ripple on the front face of the skin, pore, etc. and the skin, and a freckle.
[0002]
[Description of the Prior Art] In order to make up foundation etc. to the skin and to obtain the desired skin, the correspondence relation between the correspondence relation between the texture (or [that the skin is / how / visible to an observer / that is]) of the skin and the physical characteristic of the skin, the class of makeup, an amount, and the physical characteristic of the skin which gave makeup is analyzed, and it is effective to define the makeup which should be given to the skin concerned. Therefore, it is made by the approach of versatility [evaluate / the skin surface state of irregular colors, such as a stain inside conditions, such as a ripple on the front face of the skin, and pore or the skin, and a freckle, / from before / analyze and].
[0003] Although there is also a method of only carrying out photomacrography of the skin and analyzing a skin surface state on the basis of that image as an approach in this case, it cannot dissociate and this approach cannot estimate [can analyze skin surface states, such as a ripple and pore, and skin internal states, such as a stain and a freckle, and] them. Therefore, in order to analyze conditions, such as a ripple and pore, separately from irregular colors, such as a stain and a freckle, and to enable it to evaluate them, the method of using polarization is proposed (JP,2-206426,A etc.).
[0004] That is, as shown in drawing 7 , it is the natural light LI to Skin S. If incidence is carried out, the part is reflected on a skin front face (surface reflected light LS), and others will be refracted inside the skin, will repeat dispersion and absorption, and they will carry out outgoing radiation from a skin front face again (internal reflection LD). In this case, the surface reflected light LS has the information on the front face of the skin (concavo-convex information, refractive index), and is internal reflection LD. It has the information inside the skin (the color of the skin, irregular color). Moreover, the surface reflected light LS When the natural light LI which carried out incidence has predetermined plane of polarization, it is incident light LI. Although reflected as the linearly polarized light of the same plane of polarization, it is internal reflection LD. Polarizability was lost.
[0005] In JP,2-206426,A, the light which has specific plane of polarization through the 1st polarizing filter is irradiated at the skin, the reflected light is received through the 2nd polarizing filter there, and the image of the skin is formed. And in this case, the polarization direction of the 1st polarizing filter and the 2nd polarizing filter is changed, the surface direct reflected light is cut from light-receiving light, and the image of the skin is mainly formed based on internal reflection. Thereby, conditions, such as a stain and a freckle, come to be acquired more clearly than the case where the polarization direction of the 1st polarizing filter and the 2nd polarizing filter is made the same.
[0006]
[Problem(s) to be Solved by the Invention] However, in the observation approach on the front face of the skin of having used the conventional polarization, like above-mentioned JP,2-206426,A, since the image based on internal reflection was formed only based on the light of the one polarization direction, there was a problem that the skin may be unable to be analyzed accurately and may be unable to be evaluated based on the image with which the image obtained was obtained unlike actual texture.
[0007] That is, the light used as the light source is usually the natural light. The natural light is unpolarized light, S polarization (polarization which has a plane of vibration perpendicular to plane of incidence), and P polarization (polarization which has a plane of vibration parallel to plane of incidence) are included by the same reinforcement, and an observer will receive the reflected light of these both sides, and will take in the texture of the skin. On the other hand, although the reflectivity of this S polarization and P polarization differs greatly according to an incident angle, for example, S polarization shows a considerable reflection factor according to a specific incident angle, P polarization is not reflected at all. Therefore, the image and texture by which the image formed based on either S polarization or P polarization is actually observed will differ from each other.
[0008] This invention tends to solve the technical problem of the above conventional techniques, and photographs the surface state of the skin in an image, and it is made not to differ from the texture of the skin from which that image is obtained by actual observation in separated and analyzing skin surface states, such as a ripple and pore, and skin internal states, such as a stain and a freckle, and evaluating, and aims at enabling it to evaluate the skin accurately.
[0009]
[Means for Solving the Problem] In this artificer dividing the reflective image of the skin into a surface reflected light image and an internal reflection image, and forming By using the both sides of S polarization and P polarization as a light which do incidence to the skin, and receiving the reflected light to each incident light about the both sides of S polarization component and P polarization

component The surface reflected light component and internal reflection component of the skin at the time of making the natural light into incident light can be computed, and the surface reflected light image and internal reflection image of the skin equal to actual texture can be obtained by this, If in doing still in this way and forming a surface reflected light image from the surface reflected light component of the skin people's visual system extracts the component belonging to the spatial-frequency band which has high sensibility and forms an image from the surface reflected light component of the skin The surface reflected light image of the skin of high sharpness can be obtained, and it came to complete a header and this invention for the ability of the analysis evaluation of the description on the front face of the skin to be carried out more at an eligibility.

[0010] Namely, this invention makes a skin front face carry out incidence of S polarization and the P polarization, respectively. S polarization component and P polarization component of the reflected light at the time of carrying out incidence of S polarization component of the reflected light at the time of carrying out incidence of the S polarization, P polarization component, and the P polarization are received, respectively. Based on those light-receiving reinforcement, it asks for the surface reflected light component or internal reflection component at the time of carrying out incidence of the natural light to the skin in independent, and the skin surface observation approach characterized by obtaining a surface reflected light image or an internal reflection image is offered.

[0011] Moreover, the approach of forming a surface reflected light image based on the component of the spatial frequency which belongs to the equivalence vision band of people's visual system among the surface reflected light components of the skin as an approach of forming the surface reflected light image suitable for the analysis of the surface state of the skin and evaluation is offered.

[0012] Furthermore, the observation result of the surface state of the skin is quantified, the power of the component of the spatial frequency which belongs to the equivalence vision band of people's visual system among the surface reflected light components of the skin is integrated as an approach of being based on that quantified numeric value, analyzing the surface state of the skin and enabling it to evaluate it, and the evaluation approach of the skin of evaluating the surface state of the skin based on this value is offered.

[0013] moreover, as skin surface observation equipment which enforces the skin surface observation approach of this invention The exposure means to which it can become from the exposure light source and a polarizing filter, and a skin front face can be made to carry out incidence of S polarization and the P polarization, respectively, The polarizing filter which makes S polarization component or P polarization component of the reflected light by S polarization or P polarization which carried out incidence to the skin from this exposure means penetrate, The image pick-up equipment which receives S polarization component or P polarization component which penetrated this polarizing filter, the control computational unit to which a monitor is made to output a surface reflected light image or an internal reflection image based on the signal from image pick-up equipment, and the skin surface observation equipment characterized by having a monitor are offered.

[0014] Hereafter, this invention is explained to a detail.

[0015] This invention is based on the following principles at the time of carrying out incidence of S polarization and the P polarization to the skin. In addition, subscripts D and S of the inside of the alphabetic character of the following explanation, and a capital letter Internal reflection and the surface reflected light are expressed, respectively, and they are p of a small letter, and s. P polarization component of incident light or the reflected light and S polarization component are expressed, respectively.

[0016] As shown in drawing 2 , it is polarizing filter 2for P polarization p from the light source 1 to Skin S. Since the polarizability of incident light is generally maintained by the surface reflected light although the reflected light will contain the surface reflected light LSp and internal reflection LDp when it lets it pass and incidence of the P polarization Lp is carried out, this surface reflected light LSp is P polarization component LSpp. It will have. On the other hand, in this surface reflected light LSp, it is S polarization component LSps. It is not contained. Therefore, it is P polarization component LSpp of I (Sp) and this surface reflected light about the reinforcement of the surface reflected light LSp. They are I (Spp) and S polarization component LSps about reinforcement. It is I (Sps) about reinforcement. When it carries out, it is a degree type (1).

[0017]

[Equation 1]

$$I(Sp) = I(Spp) + I(Sps)$$

$$= I(Spp) \quad (\because I(Sps) = 0) \qquad \text{式 (1)}$$

It is expressed.

[0018] Moreover, internal reflection is P polarization component LDpp, in order that polarizability may generally disappear about the internal reflection LDp in this case. S polarization component LDps It is contained and both intensity ratio is set to 1:1. Therefore, it is [reinforcement / of internal reflection LDp] I (Dps) about I (Dpp) and S polarization component in the reinforcement of I (Dp) and P polarization component of this internal reflection. When it carries out, it is a degree type (2).

[0019]

[Equation 2]

$$I(Dp) = I(Dpp) + I(Dps)$$

$$= 2 \cdot I(Dpp)$$

$$= 2 \cdot I(Dps) \quad (\because I(Dpp) = I(Dps)) \qquad \text{式 (2)}$$

It is expressed.

[0020] Therefore, on-the-strength [of P polarization component in the total reflected light which doubled the surface reflected light LSp and internal reflection LDp] I (pp) is [0021] like a degree type (3).

[Equation 3]

$$I(pp) = I(Spp) + I(Dpp)$$
$$= I(Sp) + I(Dp)/2 \quad \text{式 (3)}$$

It is expressed and on-the-strength [of S polarization component at this time] I (ps) is [0022] like a degree type (4).
[Equation 4]
$$I(ps) = I(Dps)$$
$$= I(Dp)/2 \quad \text{式 (4)}$$

It is expressed.
[0023] Therefore, on-the-strength [of P polarization component in the respectively total reflected light] I (pp) and on-the-strength [of S polarization component] I (pS) are used for on-the-strength [of the surface reflected light LSp] I (Sp), and on-the-strength [of internal reflection LDp] I (Dp), and as shown in a degree type (5) and (6), it are [0024].
[Equation 5]
$$I(Sp) = I(pp) - I(ps) \quad \text{式 (5)}$$

[0025]
[Equation 6]
$$I(Dp) = 2 \cdot I(ps) \quad \text{式 (6)}$$

It is expressed.
[0026] On-the-strength [of P polarization component / in / when similarly it lets the polarizing filter for S polarization pass from the light source 1 and incidence of the S polarization Ls is carried out to the skin / in on-the-strength / of the surface reflected light LSs / I (Ss) and on-the-strength / of internal reflection LDs / I (Ds) / the respectively total reflected light] I (sp), and on-the-strength [of S polarization component] I (ss) are used, and it is [0027] as shown in a degree type (7) and (8).
[Equation 7]
$$I(Ss) = I(ss) - I(sp) \quad \text{式 (7)}$$

[0028]
[Equation 8]
$$I(Ds) = 2 \cdot I(sp) \quad \text{式 (8)}$$

It is expressed.
[0029] by the way, the surface reflected light LS at the time of carrying out incidence of the natural light to the skin, since the natural light is unpolarized light and the reinforcement of P polarization and S polarization is equal On-the-strength I (S) Are equal to the sum with on-the-strength [with the surface reflected light LSs at the time of carrying out incidence of the S polarization to on-the-strength / of the surface reflected light LSp at the time of carrying out incidence of the P polarization to the skin / I (Sp)] I (Ss). Moreover, internal reflection LD at the time of carrying out incidence of the natural light to the skin On-the-strength I (D) If equal to the sum with the reinforcement of the internal reflection LDs at the time of carrying out incidence of the S polarization to the reinforcement of the internal reflection LDp at the time of carrying out incidence of the P polarization to the skin, Lycium chinense will grow.
[0030] Therefore, it is [0031] as shown in the degree type (9) from above-mentioned formula (5) - (8), and (10).
[Equation 9]
$$I(S) = I(Sp) + I(Ss)$$
$$= (I(pp) - I(ps)) + (I(ss) - I(sp)) \quad \text{式 (9)}$$

[0032]
[Equation 10]
$$I(D) = 2 \cdot I(ps) + 2 \cdot I(sp) \quad \text{式 (10)}$$

It can express. Therefore, on-the-strength [of P polarization component of the reflected light at the time of carrying out incidence of the P polarization to the skin] I (pp) and on-the-strength [of S polarization component] I (ps), And by measuring on-the-strength [of P polarization component of the reflected light at the time of carrying out incidence of the S polarization to the skin] I (sp), and on-the-strength [of S polarization component] I (ss), respectively on-the-strength [of the surface reflected light component at the time of carrying out incidence of the natural light to the skin from a formula (9)] I (S) computable — on-the-strength [of a formula (10) to an internal reflection component] I (D) It can compute.
[0033] In the skin surface observation approach of this invention, after obtaining the reinforcement of the surface reflected light component at the time of carrying out incidence of the natural light in this way, and the reinforcement of an internal reflection component, based on these, a surface reflected light image and an internal reflection image are formed with a conventional method.

And conditions, such as a ripple and pore, are analyzed and evaluated from a surface reflected light image. Moreover, irregular colors, such as a stain and a freckle, are analyzed and evaluated from an internal reflection image.
[0034] By the way, in order to analyze surface states, such as a ripple on the front face of the skin, and pore, to an eligibility and to enable it to evaluate them to it more, it is desirable to raise the sharpness of a surface reflected light image. It is effective to form a surface reflected light image using the surface reflected light component of the spatial frequency which belongs to the equivalence vision band of people's visual system among the surface reflected light components of the skin for that purpose.
[0035] that is Granger and others as that to which a visual system has sensibility only in 10-40 spatial-frequency [/mm] (3.5-13CPD) bands on a retina the equivalence vision band (Equivalent Eye Bandpass) is specified (it Function(s) (SQF) E. — M.Granger, KN.Cupery, and "An Optical Merit [ ] —) which correlates with subjective Image Judgements" Photogr.Sci.Eng., 16,221 (1972).
[0036] Then, also in this invention, among the surface reflected light component of the skin, and the surface reflected light component of the skin obtained according to the skin surface observation approach of this desirable above-mentioned invention, that spatial frequency extracts the thing belonging to the range of an equivalence vision band, and forms a surface reflected light image. Thereby, the formed image is vividly recognized by high sensitivity to people's visual system. Furthermore, although the spatial frequency belongs to the range of an equivalence vision band among the surface reflected light components of the skin, by integrating power, the surface state of the skin can be quantified and it becomes possible to evaluate the surface state of the skin accurately by making the addition value into an index.
[0037] As equipment which enforces the skin surface observation approach of this invention as shown in the outline block diagram shown in drawing 1., it shall consider as the exposure means it is made to be made to carry out incidence of P polarization and the S polarization to Skin S, respectively, and it shall have the exposure light source 1 and a polarizing filter 2. In this case, as a polarizing filter 2, filter 2p for P polarization and filter 2s for S polarization may be prepared separately, and one polarizing filter which achieved the function of the both sides of the filter for P polarization and the filter for S polarization as was able to change the installation include angle of a polarizing filter suitably may be prepared.
[0038] Moreover, to the equipment of this invention, it shall have the polarizing filter 3 which enables it to receive independent ** for S polarization component and P polarization component of the reflected light as a light-receiving means of the reflected light from Skin S. Also as a polarizing filter 3 for this light-receiving, filter 3p for P polarization and filter 3s for S polarization may be prepared separately, and one polarizing filter which achieved the function of the both sides of the filter for P polarization and the filter for S polarization as was able to change the installation include angle of a polarizing filter suitably may be prepared.
[0039] It has image pick-up equipment 4 which receives S polarization component and P polarization component of the reflected light obtained through the polarizing filter 3 in the latter part of a polarizing filter 3. It is based on a signal (I (pp), I (ps), I (sp), I (ss)) from this image pick-up equipment. The principle of this above-mentioned invention is followed and it is the surface reflected light image GS. And internal reflection image GD It shall compute and shall have the control computational unit 5 outputted to a monitor 6, and the monitor 6 which displays this result.
[0040] In this case, a common computer etc. can be used as long as exposure light source [which constitutes this equipment] 1, polarizing filter 2 and 3, image pick-up equipment 4, and monitor 6 the very thing has incorporated the operation to which what is used for conventional skin surface observation equipment could be used, and the control computational unit 5 also followed the principle of this above-mentioned invention as those contents of control.
[0041] Moreover, a part of exposure means and light-receiving means [at least] are unified in one compact handicap type observation equipment, and you may make it connect other equipment elements to compact observation equipment as a concrete mode of this equipment, or may make it install each equipment element separately.
[0042]
[Function] In according to the skin surface observation approach of this invention, dividing the reflected light image of the skin into a surface reflected light image and an internal reflection image, and forming Use the both sides of S polarization and P polarization as a light which do incidence to the skin, and the reflected light to each incident light is received about the both sides of S polarization component and P polarization component. Based on those light-receiving reinforcement, the reinforcement of the surface reflected light component of the skin at the time of making the natural light into incident light and the reinforcement of an internal reflection component are computed. Therefore, the surface reflected light image and internal reflection image of the skin which will be obtained from now on become a thing adapted to actual texture.
[0043] If in doing still in this way and forming the surface reflected light image of the skin from the surface reflected light component of the skin people's visual system extracts the component belonging to the spatial-frequency band which has high sensibility and forms an image from a surface reflected light component, the sharpness of a surface reflected light image will become high, and will become possible [analyzing and evaluating the description on the front face of the skin to an eligibility more]. Moreover, by integrating the component which carried out in this way and was extracted, it becomes possible to quantify the surface state of the skin, and it becomes possible to evaluate the surface state of the skin accurately based on the numeric value acquired by this quantification.
[0044]
[Example] Hereafter, this invention is concretely explained based on an example. In addition, in each drawing explaining an example, the same sign expresses the same or equivalent component.
[0045] Drawing 3 is the explanatory view of the photography system of the skin faced and used for enforcing the skin surface observation approach of this invention.
[0046] As shown in this drawing, this system has polarizing plate 8a in the light source 1 and its front face so that predetermined polarization can be irradiated at a test subject's 7 skin S. In this case, as the light source 1, metal halide light source (color temperature of 5700 degrees C) 2 LGT of 1200W is used, putting it in order at intervals of 1000mm, HN32 by the Polaroid company is used as polarizing plate 8a, and they are the light source 1 and the distance d1 with a test subject's 7 skin S. It is referred to as 1600mm and is the installation height h1 of the light source 1. It could be 1700mm from the floor line.
[0047] Moreover, the Hi-Vision camera 9 for still pictures (the NIKON CORP. make, CF1000) which prepared polarizing plate 8b in the

front face was used as a light-receiving system of the reflected light from Skin S. Distance d2 with the skin S of this camera 9 and a test subject 7 It was referred to as 770mm and the installation height h2 of a camera 9 was set to 1100mm from the floor line. moreover, as polarizing plate 8b, it is the same as that of polarizing plate 8a prepared in the front face of the light source 1 — thing use was carried out.

[0048] Since many [as compared with the conventional video image (NTSC) / as about 6 times], the workstation was used for the amount of information of the image photoed with this Hi-Vision camera 9 for still pictures as a control computational unit, and it saved image information as a digital image, and carried out analysis processing.

[0049] in addition, the reflected light from Skin S is the same as the light source 1 — a part — Mitsunari — a part — from — since it becomes, the surface reflected light image of the skin becomes colorless, and R component which constitutes an image, G component, and B component will have the same information. Then, only G component was used in the analysis of the surface reflected light of the skin.

[0050] In such a system, one woman in her twenties is made into a test subject 7, and this test subject's surface reflected light image and internal reflection image of a cheek next to the skin are obtained. A further comparison sake, When the image was obtained without using a polarizing plate with the same camera, the surface reflected light image obtained by this system has checked that the wrinkles of the skin and the information on pore were included sharply, and the information on irregular colors, such as a freckle and a stain, was sharply included in the internal reflection image.

[0051] Moreover, it is (A) to the skin S which makes female trinominal of his twenties a test subject, and is made into an observation part. It is (B) when face toilet and a milky lotion are applied. It is (C) when only cream-like foundation is applied. About the case where cream-like foundation and face powder are applied, the surface reflected light image was obtained similarly (image size: 1024x1024 pixels). Consequently, the above (A) (B) (C) It was clear that pore had stopped being conspicuous in order of the makeup skin.

[0052] Furthermore, an observation part is considered as a part for a bridge flank with comparatively much pore, and it is (A) like the above. It is (B) when face toilet and a milky lotion are applied. It is (C) when only cream-like foundation is applied. The surface reflected light image was formed about the case where cream-like foundation and face powder are applied. However, on the occasion of formation of a surface reflected light image, the fourier power spectrum of each surface reflected light component was computed. The result is shown in drawing 4 .

[0053] In addition, analysis of an image was performed by starting 256x256-pixel size. Moreover, calculation of the fourier power spectrum was performed as follows.

[0054] That is, the Fourier transform of Image f (x y) is set to F (x y), the power is set to phi, and these are expressed to a case like a degree type.

[0055]

[Equation 11]

$$F(u,v)=\int\int_{-\infty}^{\infty} \exp(-2i\pi(ux+vy))\, f(x,y)\,dx\,dy$$

[0056]

[Equation 12]

$$\Phi(u,v)=F(u,v)\cdot F^{*}(u,v)=|F(u,v)|^{2}$$

Then, in this example, the value which integrated with the power phi in a two-dimensional spatial-frequency flat surface like [field / of the distance ri from a zero - rj+**r / ring-like] a degree type was calculated. Here, j is the number of a ring field.

[0057]

[Equation 13]

$$A(r_j)=\int_{0}^{\pi}\int_{r_j}^{r_j+\Delta r} \Phi(r,\theta)\,dr\,d\theta \qquad j=1,2,\ldots,m$$

[0058]

[Equation 14]

$$r=\sqrt{u^{2}+v^{2}}$$

[0059]

[Equation 15]

$$\theta=\tan^{-1}(v/u)$$

moreover, the number of cycles of the sine wave which exists in an angle of visibility when the spatial frequency (CPD:Cycle Per Dgree) of an axis of abscissa assumes a test subject's observation distance to 30cm in drawing 4 — being shown — **** — an axis of ordinate — the logarithm of power — it is a value and the amount depending on the amplitude of a sine wave and sine wave's existence frequency is shown.

[0060] It is (A) to the frequency region of the result of this drawing 4 to spatial-frequency 5-30CPD. It is (B) when face toilet and a milky lotion are applied. It is (C) when only cream-like foundation is applied. It turned out that the remarkable difference at the time of applying cream-like foundation and face powder appears. Then, when spatial frequency integrated the power of the thing of an equivalence vision band within the limits like a degree type, the image characteristic quantity S was computed.

[0061]

[Equation 16]

$$S=\int_{10}^{40}\log(A(r_j))d\log r_j=\int_{3.5}^{13}\log(A(r))d\log(r)$$

(The inside of a formula, rj (system of units: mm/), and r (system of units: CPD) are spatial frequency, and A is a power spectrum) This result is shown in drawing 5 . The image characteristic quantity S made into the axis of ordinate in drawing 5 expresses that the sharp nature of an image is so low that the value is small. moreover, each above-mentioned makeup skin (A) (B) (C) the ratio to the image characteristic quantity S of the bare skin of image characteristic quantity — R — asking — drawing 6 — the ratio — R and each makeup skin (A) (B) (C) Relation with a subjectivity evaluation value was carried out. In addition, each makeup skin (A) (B) (C) The subjectivity evaluation value was calculated with the pair comparison method of SHIEFFE which made evaluation criteria extent of the ease of being visible of the irregularity of pore.

[0062] This drawing 5 to (A) It is (B) when face toilet and a milky lotion are applied. When only a cream-like foundation is applied, (C) The image characteristic quantity S becomes small at the order at the time of applying cream-like foundation and face powder. a ratio [further as opposed to / it turns out that the value of the image characteristic quantity S and the difficulty of being visible of pore are in agreement, and / the image characteristic quantity S of the bare skin of the image characteristic quantity S of drawing 6 to the makeup skin] — it turns out that it has the correlation (correlation coefficient 0.96) with high R and subjectivity evaluation value. Therefore, it has checked that the image characteristic quantity S was effective in quantification of the surface state of the skin.

[0063]

[Effect of the Invention] According to this invention, the surface state of the skin is photographed in an image, and in separating and analyzing skin surface states, such as a ripple and pore, and skin internal states, such as a stain and a freckle, and evaluating, based on the image adapted to the texture of the actual skin, it becomes possible to evaluate the skin accurately. Furthermore, the surface reflected light image of the skin is obtained with high sharpness, and it also becomes possible to quantify the surface state of the skin.

[Translation done.]

DESCRIPTION OF DRAWINGS

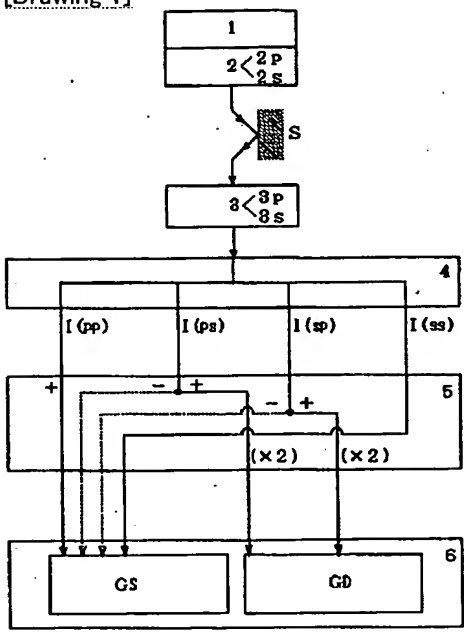
[Brief Description of the Drawings]
[Drawing 1] It is the explanatory view of the equipment of this invention.
[Drawing 2] It is the explanatory view of the principle of the skin surface observation approach of this invention.
[Drawing 3] It is the schematic diagram of the system of an example.
[Drawing 4] It is the fourier power spectrum Fig. of a surface reflected light component.
[Drawing 5] It is the related Fig. of the image characteristic quantity and the class of makeup skin based on a surface reflected light component.
[Drawing 6] the ratio to the image characteristic quantity of the bare skin of the image characteristic quantity of the makeup skin — it is the related Fig. of R and the subjectivity evaluation value of the makeup skin.
[Drawing 7] It is the explanatory view of surface reflection when the natural light carries out incidence to the skin, and internal reflection.
[Description of Notations]
1 Light Source
2 Polarizing Filter
2p The polarizing filter for P polarization
2s Polarizing filter for S polarization
3 Polarizing Filter
4 Image Pick-up Equipment
5 Control Computational Unit
6 Monitor
7 Test Subject
8 Polarizing Plate
9 Camera
I (D) Reinforcement of the internal reflection at the time of natural light incidence
Reinforcement of P polarization component of the internal reflection at the time of I (Dpp) P polarization incidence
Reinforcement of S polarization component of the internal reflection at the time of I (Dps) P polarization incidence
I (Ds) Reinforcement of the internal reflection at the time of S polarization incidence
I (pp) Reinforcement of P polarization component of the total reflected light which doubled the surface reflected light and internal reflection at the time of P polarization incidence
I (ps) Reinforcement of S polarization component of the total reflected light which doubled the surface reflected light and internal reflection at the time of P polarization incidence
I (S) Reinforcement of the surface reflected light at the time of natural light incidence
I (Sp) Reinforcement of the surface reflected light at the time of P polarization incidence
Reinforcement of P polarization component of the surface reflected light at the time of I (Spp) P polarization incidence
Reinforcement of S polarization component of the surface reflected light at the time of I (Sps) P polarization incidence
I (Ss) Reinforcement of the surface reflected light at the time of S polarization incidence
I (sp) Reinforcement of P polarization component of the total reflected light which doubled the surface reflected light and internal reflection at the time of S polarization incidence
I (ss) Reinforcement of S polarization component of the total reflected light which doubled the surface reflected light and internal reflection at the time of S polarization incidence
LI Incident light
LD Internal reflection
LDpp P polarization component of the internal reflection at the time of P polarization incidence
LDps S polarization component of the internal reflection at the time of P polarization incidence
Lp P polarization
Ls S polarization
LS Surface reflected light
LSpp P polarization component of the surface reflected light to P polarization incident light
LSps S polarization component of the surface reflected light to P polarization incident light
S Skin

* NOTICES *

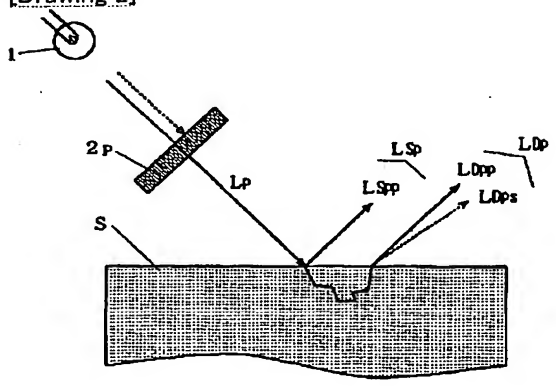
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

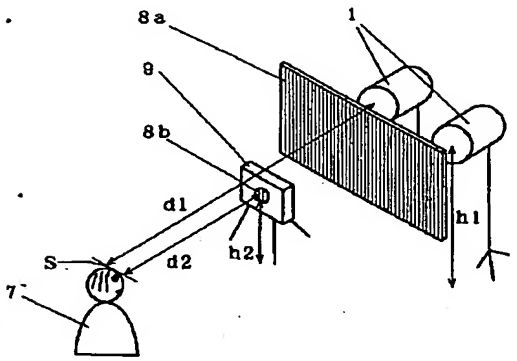
[Drawing 1]



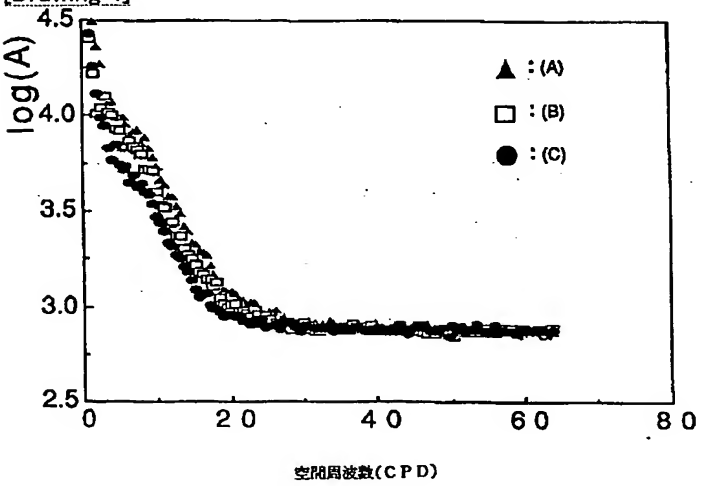
[Drawing 2]



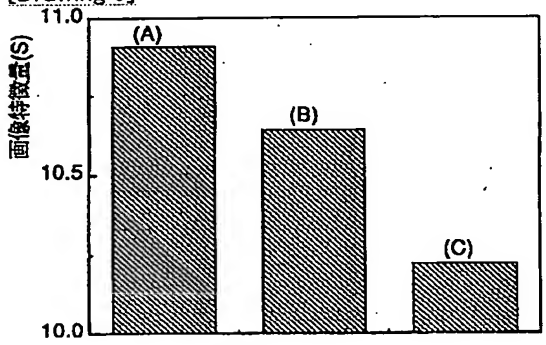
[Drawing 3]



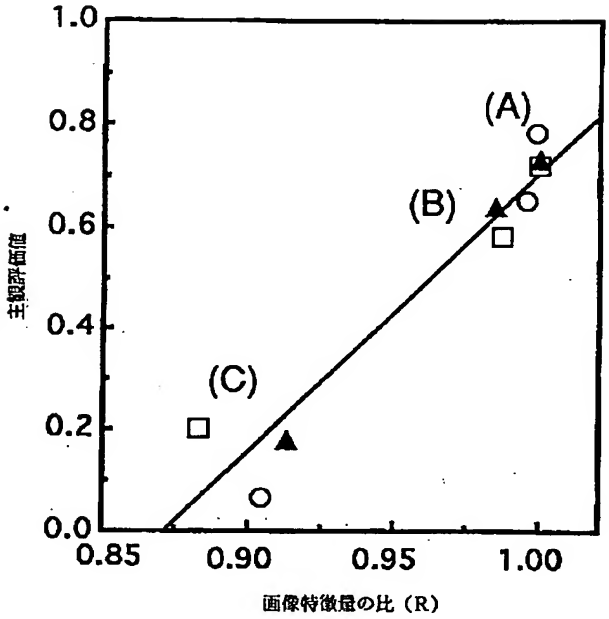
[Drawing 4]



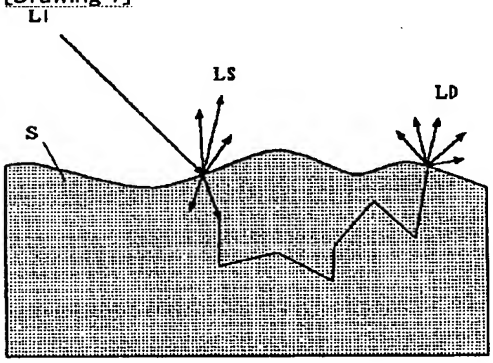
[Drawing 5]



[Drawing 6]



[Drawing 7]



[Translation done.]